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Process to prepare base oils from a fisher-tropsch synthesis product

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Process to prepare base oils from a Fischer-Tropsch  
synthesis product

The present invention is directed to a process to prepare base oils or the intermediate waxy raffinate product in a high yield from a Fischer-Tropsch synthesis product.

5        Such processes are known from WO-A-9941332,  
US-A-6080301, EP-A-0668342, US-A-6179994 or  
WO-A-02070629. These processes all comprise some kind of  
hydroisomerisation of the Fischer-Tropsch synthesis  
product followed by a dewaxing step of the higher boiling  
10       fraction obtained in said hydroisomerisation.

      WO-A-02070629, for example, describes a process  
wherein the C5 plus fraction of a Fischer-Tropsch  
synthesis product is first subjected to a  
hydrocracking/hydroisomerising step in the presence of  
15       a catalyst consisting of platinum on an amorphous silica-  
alumina carrier. The effluent of this conversion step is  
separated into middle distillate products and a base oil  
precursor fraction and a higher boiling fraction. The  
base oil precursor fraction is catalytically dewaxed in  
20       the presence of a platinum-ZSM-5 based catalyst and the  
heavy fraction is recycled to the  
hydrocracking/hydroisomerising step.

      Although such a process will yield excellent quality  
base oils there is room for improvement. Especially the  
25       yield of base oils relative to the Fischer-Tropsch  
synthesis product may be improved. Especially for base

oils having a kinematic viscosity at 100 °C of between 2 and 8 cSt an improved yield would be welcome.

The present invention aims at providing such a process.

5       The following process achieves this object. Process to prepare base oils from a Fischer-Tropsch synthesis product by

10       (a) separating the Fischer-Tropsch synthesis product into a fraction (i) boiling in the middle distillate range and below, a heavy ends fraction (iii) and an intermediate base oil precursor fraction (ii) boiling between fraction (i) and fraction (iii),

15       (b) subjecting the base oil precursor fraction (ii) to a catalytic hydroisomerisation and catalytic dewaxing process to yield one or more base oil grades,

      (c) subjecting the heavy ends fraction (iii) to a conversion step to yield a fraction (iv) boiling below the heavy ends fraction (iii) and

20       (d) subjecting the high boiling fraction (v) of fraction (iv) to a catalytic hydroisomerisation and catalytic dewaxing process to yield one or more base oil grades.

25       Applicants have found that by directly subjecting the fraction of the intermediate fraction (ii) of the Fischer-Tropsch synthesis product and the high boiling fraction (v) as obtained in step (c) to a selective isomerisation and dewaxing step a higher yield to base oils relative to the Fischer-Tropsch synthesis product can be obtained.

30       Without intending to be bound by the following theory it is believed that the high yield to base oils is achieved in that the fraction boiling in the base oil range, i.e. fractions (ii) and (v), are directly

contacted with the catalytic isomerisation and dewaxing catalysts. In the prior art process of WO-A-02070629 the corresponding fraction of the Fischer-Tropsch synthesis product was first contacted with a catalyst which would  
5 convert a large part to middle distillate products and lower boiling products. By using this different line-up the conversion of potential base oil molecules in the Fischer-Tropsch synthesis product to middle distillate molecules is minimized. Furthermore in the process of  
10 WO-A-02070629 the heavy fraction as obtained in the hydrocracking/hydroisomerising step is recycled to said step. This results in that more potential base oil molecules are converted to middle distillate molecules.

The Fischer-Tropsch synthesis product can be obtained  
15 by well-known processes, for example the so-called commercial Sasol process, the Shell Middle Distillate Process or by the non-commercial Exxon process. These and other processes are for example described in more detail in EP-A-776959, EP-A-668342, US-A-4943672, US-A-5059299,  
20 WO-A-9934917 and WO-A-9920720. Typically these Fischer-Tropsch synthesis products will comprise hydrocarbons having 1 to 100 and even more than 100 carbon atoms. The hydrocarbon product will comprise (iso)paraffins, oxygenated products and unsaturated products. The feed to  
25 step (a) or any fractions obtained in step (a) may be hydrogenated in order to remove any oxygenates or unsaturated products. The process of the present invention is especially advantageous when a substantial part, preferably more than 10 wt%, more preferably more  
30 than 30wt% and even more preferably more than 50 wt% of the Fischer-Tropsch synthesis product boils above 550 °C. An example of a suitable process which may prepare such a

heavy Fischer-Tropsch synthesis product is described in WO-A-9934917 and in AU-A-698392.

5 In step (a) the Fischer-Tropsch synthesis product is separated into a fraction (i) boiling in the middle distillate range and below, a heavy ends fraction (iii) preferably, having an initial boiling point between 500 and 600 °C and an intermediate base oil precursor fraction (ii) boiling between fraction (i) and fraction (iii). Suitably the Fischer-Tropsch synthesis product is first fractionated at atmospheric pressure or higher to obtain fraction (i) boiling in the middle distillate range and below. Fractionation may be performed by flashing or distillation. The middle distillate range is sometimes defined as the fraction boiling predominately, 10 i.e. for more than 90 wt%, between 200 and 350 °C and it comprises the gas oil and kerosene fractions, which can be isolated from the Fischer-Tropsch synthesis product. The residue or bottom product of the atmospheric fractionation is further separated at near vacuum 15 pressure to the heavy ends fraction (iii) having an initial boiling point between 500 and 600 °C and the intermediate base oil precursor fraction (ii). 20

In step (b) the base oil precursor fraction (ii) is subjected to a catalytic hydroisomerisation and catalytic 25 dewaxing process to yield one or more base oil grades. These catalytic processes are defined according to this invention as processes, which are selective for reducing the pour point of this fraction while minimising the conversion of molecules boiling above 370 °C to molecules 30 boiling below 370 °C. It should be noted that when lower temperature pour points are desired for the base oil more molecules will, even by the more selective isomerisation and dewaxing processes, be converted to fractions boiling

below 370 °C. Selective isomerisation and dewaxing processes are preferably processes wherein less than 40 wt%, more preferably less than 30 wt%, of the feed to step (b) is converted to a fraction boiling below 370 °C when preparing a base oil having a kinematic viscosity at 100 °C of 5 cSt and having a pour point of -27 °C and a Noack volatility of 10 wt%. Examples of processes having the above described selectivity to base oils are well known and will be described below.

In step (b) the catalytic hydroisomerisation and catalytic dewaxing may be performed by one catalyst or by separate dedicated isomerisation and dewaxing catalysts.

Examples of possible isomerisation catalysts comprise a Group VIII metal, ie. Nickel, platinum or palladium on a refractory oxide carrier.

Such separate isomerisation processes in combination with a catalytic dewaxing process is for example described in EP-A-776959. Use can be made in step (b) of the well known catalytic dewaxing processes wherein catalysts are used comprising medium pore size molecular sieves and a hydrogenation component, preferably a noble metal such as platinum or palladium. Examples of such processes are those based on SAPO-11 as described in for example EP-A-458895, ZSM-5 as for example described in EP-B-832171, ZSM-23 as described in for example EP-A-540590 and EP-A-092376, ZSM-22 as for example described in US-A-4574043, mordenite as for example described in US-A-6179994 and ferrierite as for example described in EP-A-1029029.

If step (b) is carried out using a single catalyst process, catalyst may be used based on for example catalysts comprising platinum-zeolite-beta, as described in for example US-A-5885438, or ZSM-23 or ZSM-22 based

catalysts as for example described in EP-A-536325. Preferably use is made of a process which makes use of a ZSM-12 based catalyst as for example described in WO-A-0107538.

5           Advantageously an isomerisation step using a catalyst based on zeolite-beta is combined with a selective catalytic dewaxing step wherein use can be made of the dewaxing catalysts described above. Examples of the use of platinum-zeolite-beta catalysed step followed by a  
10   more selective dewaxing step using a platinum-ZSM-23 catalysed step is for example in US-A-4919788 and EP-A-1029029. The ZSM-23, ZSM-22 and ZSM-12 catalysts may also be used in a cascade dewaxing operation wherein the final dewaxing is performed making use of a more  
15   restricted pore size zeolite like for example ZSM-5, ZSM-11 or ferrierite as for example described in US-A-4599162.

          A most preferred process for step (b) comprises contacting the fraction (ii) with a catalyst comprising  
20   ZSM-12, platinum and a binder. It has been found that this process achieves a high selectivity to base oils. Another advantage is less gaseous by-products and more gas oil by-products are made. Preferably the binder is a low acidity binder comprising essentially no alumina.  
25   Preferably the binder is silica. More preferably the zeolite is dealuminated and more preferably a dealumination treatment is chosen which claims to selectively dealuminate the surface of the ZSM-12 crystallites. Such catalysts and the process conditions  
30   for performing this process are described in more detail in WO-A-0107538.

          After performing a dewaxing step (b) the desired base oil(s) are preferably isolated from the dewaxed effluent



in a base oil recovery step (e). In this step (e) lower boiling compounds formed during catalytic dewaxing are removed, preferably by means of distillation, optionally in combination with an initial flashing step. By choosing a suitable distillation cut as feed to step (b) in step (a) it is possible to obtain a single desired base oil directly after a catalytic dewaxing step (b) without having to remove any higher boiling compounds from the end base oil grade. Examples of very suitable grades are base oils having a kinematic viscosity at 100 °C of between 3.5 and 6 cSt.

It has also been found possible to make more than one viscosity grade base oil with the process according to the invention. By obtaining a base oil precursor fraction (ii) in step (a) having a more broad boiling range more base oil grades may advantageously be obtained in step (e). Preferably the difference between the T10wt% recovery point and the 90wt% recovery point in the boiling curve is larger than 100 °C. In this mode the effluent of step (b) is separated into various distillate fractions comprising two or more base oil grades. In order to meet the desired viscosity grades and volatility requirements of the various base oil grades preferably off-spec fractions boiling between, above and/or below the desired base oil grades are also obtained as separate fractions. These fractions and any fractions boiling in the gas oil range or below may advantageously be recycled to step (a). Alternatively fractions obtained boiling in the gas oil range or below may suitably be used as a separate blending component to prepare a gas oil fuel composition.

The separation into the various fractions in step (e) may suitably be performed in a vacuum distillation column

provided with side strippers to separate the fraction from said column. In this mode it is found possible to obtain for example a 2-3 cSt product, a 4-6 cSt product and a 7-10 cSt product simultaneously from a single base oil precursor fraction (ii). The viscositie values are the kinematic viscosity at 100 °C.

In step (c) the heavy ends fraction (iii) is subjected to a conversion step to yield a fraction (iv) boiling below the heavy ends fraction (iii). Preferably a hydrocracking/ hydroisomerisation reaction takes place in step (c). Step (c) is preferably performed in the presence of hydrogen and a catalyst, which catalyst can be chosen from those known to one skilled in the art as being suitable for this reaction. Catalysts for use in step (c) typically are amorphous catalysts comprising an acidic functionality and a hydrogenation/dehydrogenation functionality. Preferred acidic functionality's are refractory metal oxide carriers. Suitable carrier materials include silica, alumina, silica-alumina, zirconia, titania and mixtures thereof. Preferred carrier materials for inclusion in the catalyst for use in the process of this invention are silica, alumina and silica-alumina. A particularly preferred catalyst comprises platinum supported on a silica-alumina carrier. If desired, the acidity of the catalyst carrier may be enhanced by applying a halogen moiety, in particular fluorine, or a phosphorous moiety to the carrier. Examples of suitable hydrocracking/hydroisomerisation processes and suitable catalysts are described in WO-A-200014179, EP-A-532118 and the earlier referred to EP-A-776959.

Preferred hydrogenation/dehydrogenation functionality's are Group VIII non-noble metals, for

example nickel and more preferably Group VIII noble metals, for example palladium and most preferably platinum. The catalyst may comprise the hydrogenation/dehydrogenation active component in an amount of from 0.005 to 5 parts by weight, preferably from 0.02 to 2 parts by weight, per 100 parts by weight of carrier material. A particularly preferred catalyst for use in the hydroconversion stage comprises platinum in an amount in the range of from 0.05 to 2 parts by weight, more preferably from 0.1 to 1 parts by weight, per 100 parts by weight of carrier material. The catalyst may also comprise a binder to enhance the strength of the catalyst. The binder can be non-acidic. Examples are clays and other binders known to one skilled in the art.

In step (c) the feed is contacted with hydrogen in the presence of the catalyst at elevated temperature and pressure. The temperatures typically will be in the range of from 175 to 380 °C, preferably higher than 250 °C and more preferably from 300 to 370 °C. The pressure will typically be in the range of from 10 to 250 bar and preferably between 20 and 80 bar. Hydrogen may be supplied at a gas hourly space velocity of from 100 to 10000 Nl/l/hr, preferably from 500 to 5000 Nl/l/hr. The hydrocarbon feed may be provided at a weight hourly space velocity of from 0.1 to 5 kg/l/hr, preferably higher than 0.5 kg/l/hr and more preferably lower than 2 kg/l/hr. The ratio of hydrogen to hydrocarbon feed may range from 100 to 5000 Nl/kg and is preferably from 250 to 2500 Nl/kg.

The conversion in step (c) as defined as the weight percentage of the feed boiling above 370 °C which reacts per pass to a fraction boiling below 370 °C is preferably at least 20 wt%, more preferably at least 25 wt%,

preferably not more than 65 wt% and more preferably not more than 50 wt%.

Step (c) may also be performed making use of a catalyst comprising a molecular sieve and a metal hydrogenation component. Examples of suitable molecular sieves are SAPO-11, ZSM-22 or ZSM-23. Preferably the molecular sieve has a pore structure of the 12-oxygen ring type. Suitable molecular sieves having a 12-member ring structure for use in the present invention are zeolite beta and ZSM-12. Suitable hydrogenation metals are preferably of Group VIII of the periodic table of elements. More preferably the hydrogenation component is nickel, cobalt and even more preferably platinum or palladium. Examples of the above catalysts are described in more detail above at step (b). An advantage of using a molecular sieve based type catalyst in step (c) is that an additional dewaxing of the resultant base oil may be omitted. In essence step (c) and step (d) are thus combined in one step. It has been found that very high viscosity base oil grades, preferably having a kinematic viscosity at 100 °C of above 15 cSt, may be prepared in this manner. The maximum viscosity will depend on the heaviness of the Fischer-Tropsch synthesis product used as feed in step (a).

Preferably the effluent of the above combined steps (c) and (d) is provided to the same above described base oil work up section (step (e)). This is advantageous because the isolation of all base oil grades, including the heavier grade, may then be performed in the same distillation column(s).

In the event step (c) is performed in the presence of a molecular sieve based catalyst the following process conditions are generally applied. The temperatures

typically will be in the range of from 175 to 380 °C, preferably higher than 200 °C and more preferably from 220 to 300 °C. The pressure will typically be in the range of from 10 to 250 bar and preferably between 20 and 80 bar. Hydrogen may be supplied at a gas hourly space velocity of from 100 to 10000 Nl/l/hr, preferably from 500 to 5000 Nl/l/hr. The hydrocarbon feed may be provided at a weight hourly space velocity of from 0.1 to 5 kg/l/hr, preferably higher than 0.5 kg/l/hr and more preferably lower than 2 kg/l/hr. The ratio of hydrogen to hydrocarbon feed may range from 100 to 5000 Nl/kg and is preferably from 250 to 2500 Nl/kg.

In step (d) the high boiling fraction (v) of fraction (iv) is subjected to a catalytic hydroisomerisation and catalytic dewaxing process to yield one or more base oil grades. The high boiling fraction (v) in the effluent of step (c) preferably has a initial boiling point of between 340 and 400 °C. The final boiling point of said fraction (v) is preferably between 500 and 600 °C. Step (d) may be performed as described above for step (b). Preferably the base oils are isolated from the effluent of step (d) in the same base oil work-up section (step (e)) as described above.

Preferably the effluent of step (c) is provided to step (a). This is advantageous because it reduces the number of distillation columns. In step (a) a mixture of fresh Fischer-Tropsch synthesis product and step (c) effluent will be separated simultaneously into again a fraction (i) boiling in the middle distillate range and below, a heavy ends fraction (iii) and an intermediate base oil precursor fraction (ii) boiling between fraction (i) and fraction (iii). In this embodiment step (b) and

(d) are performed in the same reactor, which is also advantageous for obvious reasons.

5 The Fischer-Tropsch synthesis may contain olefins and oxygenates which may be detrimental for the catalysts used in step (b), (c) and (d). These compounds may be removed by means of hydrogenation of the Fischer-Tropsch synthesis product prior to performing step (a) or hydrogenation of the feeds to the separate steps (b), (c) and/or (d). The latter is advantageous because some of  
10 the oxygenates present in the Fischer-Tropsch synthesis product will end up in the middle distillate fraction (i) and could serve as lubricity enhancers in the resulting gas oil or kerosene fractions. The advantages of the presence of such compounds are for example described in  
15 EP-A-101553.

Possible hydrogenation processes are for example described in EP-B-668342. The mildness of the hydrotreating step is preferably expressed in that the degree of conversion in this step is less than 20 wt% and  
20 more preferably less than 10 wt%. The conversion is here defined as the weight percentage of the feed boiling above 370 °C, which reacts to a fraction boiling below 370 °C. Examples of possible hydrogenation processes involve the use of nickel containing catalysts, for example nickel on alumina, nickel on silica-alumina  
25 or nickel on Kieselguhr. The hydrogenation conditions are typical conditions for these type of processes, well known to the skilled person.

30 The invention is also directed to a process to prepare the intermediate fraction (ii). This fraction may be referred to as a waxy raffinate fraction boiling preferably for more than 90 wt% between 370 and 550 °C. The process to prepare this intermediate product is

preferably performed starting from a Fischer-Tropsch synthesis product which boils for more than 40 wt% and more preferably more than 50 wt% above 550 °C. The process involves the following steps:

- 5 (aa) separating the Fischer-Tropsch synthesis product into a fraction (i) boiling in the middle distillate range and below, a heavy ends fraction (iii) having an initial boiling point between 500 and 600 °C and a waxy raffinate fraction (ii) boiling between fraction (i) and  
10 heavy ends fraction (iii),  
(bb) subjecting the heavy ends fraction (iii) to a conversion step wherein part of the heavy ends fraction is converted to lower boiling compounds and recycling the effluent of the conversion step to step (aa).

15 The conversion step (bb) may be the above referred to hydroconversion steps as described for step (c) above. Alternatively thermal cracking may also be applied to convert the heavy ends. Preferably the products of the thermal cracker step (b) are hydrogenated such to at  
20 least hydrogenate the di-olefins which could be present in said product.

The waxy raffinate may be sold as a separate product. For example it may be prepared at a gas producing location and further processed to end products like for  
25 example base oils at a location more close to the end costumers. The raffinate itself may find use as feedstock to prepare base oils as described above. The waxy raffinate product can also be advantageously be used as steam cracker feedstock to prepare lower olefins, for  
30 example ethylene and propylene. Because of its high paraffinic content high yields to lower olefins are possible when using such a feedstock as steam cracker feedstock.

Preferably the above process involving a thermal cracking step for step (bb) is used as a feed preparation process for a steam cracker located just down stream of said process. A possible steam cracker process could be designed to run on a combination of said waxy raffinate product and on the lower boiling fractions (i), boiling in the naphtha to gas oil range, as obtained in step (aa) in dedicated steam cracker furnaces.

The invention will also be illustrated by making use of Figures 1-4.

Figure 1 illustrates a state of the art process of WO-A-02070629.

Figure 2 illustrates a process according to the invention.

Figure 3 illustrates a process according to the invention.

Figure 4 illustrates a process according to the invention.

Figure 1 describes a state of the art process line-up according to WO-A-02070629 illustrating a Fischer-Tropsch synthesis process step 1 wherein a Fischer-Tropsch product 2 is prepared. This product 2 is fed to a hydrocracking/hydroisomerisation step 3. Product 4 is subsequently separated in an atmospheric distillation column 5 into a naphtha product 6, a kerosene product 7, a gas oil product 8 and a bottoms product. The bottoms product is subsequently separated in a vacuum distillation column 9 into a base oil precursor fraction 10 and a higher boiling fraction 17. The fraction 10 is subsequently catalytically dewaxed 11 and the dewaxed oil 12 is fractionated in column 13 into various base oil products 14, 15 and 16. The higher boiling fraction 17 is recycled to hydrocracking/hydroisomerisation step 3.



Figure 2 illustrates an embodiment of the present invention. In a Fischer-Tropsch synthesis process step 20 a Fischer-Tropsch product 21 is prepared. This product 21 is separated by means of distillation 22 in one or more middle distillate fractions 34, 35, which may be naphtha, kerosene and gas oil, into a base oil precursor fraction 36 and a higher boiling fraction 23. Distillation 22 may be a atmospheric distillation and a vacuum distillation scheme as in Figure 1. The base oil precursor fraction is fed to a catalytic dewaxing step 30 and the dewaxed oil 34 is fractionated in column 32 into one or more base oil products 35, 36 and 37. The higher boiling fraction 23 is fed to a hydrocracking/hydroisomerisation step 24 yielding a cracked product 25. From this product 25 a fraction boiling in the gas oil range and below 38, a base oil precursor fraction 27 and a higher boiling fraction 33 is separated in column 26. The base oil precursor fraction 27 is catalytic dewaxed 28 and the dewaxed oil is combined with dewaxed oil 34 to be separated in 32 as described above.

Figure 3 is a process as in Figure 2 wherein the products obtained in the hydrocracking/hydroisomerisation step 44 is recycled to the first separation unit 42. As can be seen by comparing Figure 2 with Figure 3 a considerable reduction in unit operations is achieved. In a Fischer-Tropsch synthesis process step 40 a Fischer-Tropsch product 41 is prepared. This product 41 is separated by means of distillation 42 in one or more middle distillate fractions 46, 47, which may be naphtha, kerosene and gas oil, into a base oil precursor fraction 48 and a higher boiling fraction 43. Distillation 42 may be a atmospheric distillation and a vacuum distillation scheme as in Figure 1. The higher boiling fraction 43 is

fed to a hydrocracking/hydroisomerisation step 44 yielding a cracked product 45, which is recycled to distillation 42.

5 The base oil precursor fraction 48 is fed to a catalytic dewaxing step 49 and the dewaxed oil 50 is fractionated in column 51 into one or more base oil products 53 and 54.

10 The gas oil product 52 as separated from the dewaxed oil is preferably blended with the gas oil fraction 47 such to obtain a blended product having favorable low temperature properties. The gas oil product 52 will have a low cloud point and cold filter plugging point (CFFP). The volume of the gas oil product 52 having the favorable low temperature properties may be controlled by adjusting  
15 the initial boiling point of the base oil precursor fraction 48. Such a control allows the operator to target the low volume of gas oil 52 and thus also the temperature properties, such as cloud point and CFFP of the resulting blend of gas oil products 52 and 47.

20 Figure 4 illustrates a process to prepare a waraffinate product 65. Figure 4 shows a Fischer-Tropsch synthesis process step 60 a Fischer-Tropsch product 61 is prepared. This product 61 is separated by means of distillation 62 in one or more middle distillate  
25 fractions 63, 64, which may be naphtha, kerosene and gas oil, into a waxy Raffinate product 65 and a higher boiling fraction 66. Distillation 62 may be an atmospheric distillation and a vacuum distillation scheme as in Figure 1. The higher boiling fraction 66 is fed to  
30 a heavy ends conversion step 67 yielding a product 68 containing on average lower boiling molecules than the feed 66. The heavy ends conversion step 67 may be a hydrocracking/ hydroisomerisation step or a thermal

cracking step. The product 68 is recycled to distillation 62. Optionally the waxy Raffinate 65 may be used as feed of a steam cracker furnace dedicated for such a feed. In a possible embodiment also a naphtha fraction 63 is fed to a dedicated steam cracker furnace. 5 The gas oil product 64 may be advantageously sold as a separate product. Because of its high Cetane Number it may be use, more advantageously as an automotive gas oil fuel component than as a steam cracker feed stock.

C L A I M S

1. Process to prepare base oils from a Fischer-Tropsch synthesis product by

(a) separating the Fischer-Tropsch synthesis product into a fraction (i) boiling in the middle distillate range and below, a heavy ends fraction (iii) and an intermediate  
5 base oil precursor fraction (ii) boiling between fraction (i) and fraction (iii),

(b) subjecting the base oil precursor fraction (ii) to a catalytic hydroisomerisation and catalytic dewaxing  
10 process to yield one or more base oil grades,

(c) subjecting the heavy ends fraction (iii) to a conversion step to yield a fraction (iv) boiling below the heavy ends fraction (iii) and

(d) subjecting the high boiling fraction (v) of  
15 fraction (iv) to a catalytic hydroisomerisation and catalytic dewaxing process to yield one or more base oil grades.

2. Process according to claim 1, wherein the heavy ends fraction (iii) has an initial boiling point of  
20 between 500 and 600 °C.

3. Process according to any one of claims 1-2, wherein step (b) is performed in the presence of a catalyst comprising a noble metal hydrogenation component and a molecular sieve selected from the group of zeolite beta, ZSM-23, ZSM-22, ZSM-35 or ZSM-12.  
25

4. Process according to any one of claims 1-3, wherein step (c) is performed as a hydrocracking/hydroisomerisation process making use of an

amorphous catalyst comprising an acidic functionality and a hydrogenation/dehydrogenation functionality.

5      5. Process according to any one of claims 1-3, wherein step (c) is performed under isodewaxing conditions in the presence of a catalyst comprising a molecular sieve having a 12 member ring structure and a metal hydrogenation components.

10      6. Process according to claim 5, wherein the conditions are so chosen that also a catalytic hydroisomerisation and catalytic dewaxing takes place such that in effect step (c) and (d) take place simultaneously.

15      7. Process according to any one of steps 1-5, wherein step (d) is performed in the presence of a catalyst comprising a noble metal hydrogenation component and a molecular sieve selected from the group of zeolite beta, ZSM-23, ZSM-22, ZSM-35 or ZSM-12.

20      8. Process according to any one of claims 1-5, wherein the effluent of step (c) is provided to step (a), such that in effect steps (b) and (d) take place simultaneously.

9. Process according to any one of claims 1-8, wherein the feeds to step (b) and/or step (c) is first hydrogenated in order to remove oxygenates and/or olefins present in such feeds.

25      10. Process to prepare a waxy raffinate fraction boiling for more than 90 wt% between 370 and 550 °C from a Fischer-Tropsch synthesis product which boils for more than 40 wt% above 550 °C by

30      (aa) separating the Fischer-Tropsch synthesis product into a fraction (i) boiling in the middle distillate range and below, a heavy ends fraction (iii) having an initial boiling point between 500 and 600 °C and a waxy raffinate fraction (ii) boiling between fraction (i) and

heavy ends fraction (iii), (bb) subjecting the heavy ends fraction (iii) to a conversion step wherein part of the heavy ends fraction is converted to lower boiling compounds and recycling the effluent of the conversion step to step (aa).

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A B S T R A C T

Process to prepare base oils from a Fischer-Tropsch  
synthesis product

Process to prepare base oils from a Fischer-Tropsch  
synthesis product by

- (a) separating the Fischer-Tropsch synthesis product into a fraction (i) boiling in the middle distillate range and below, a heavy ends fraction (iii) and an intermediate base oil precursor fraction (ii) boiling between fraction (i) and fraction (iii),
- (b) subjecting the base oil precursor fraction (ii) to a catalytic hydroisomerisation and catalytic dewaxing process to yield one or more base oil grades,
- (c) subjecting the heavy ends fraction (iii) to a conversion step to yield a fraction (iv) boiling below the heavy ends fraction (iii) and
- (d) subjecting the high boiling fraction (v) of fraction (iv) to a catalytic hydroisomerisation and catalytic dewaxing process to yield one or more base oil grades.

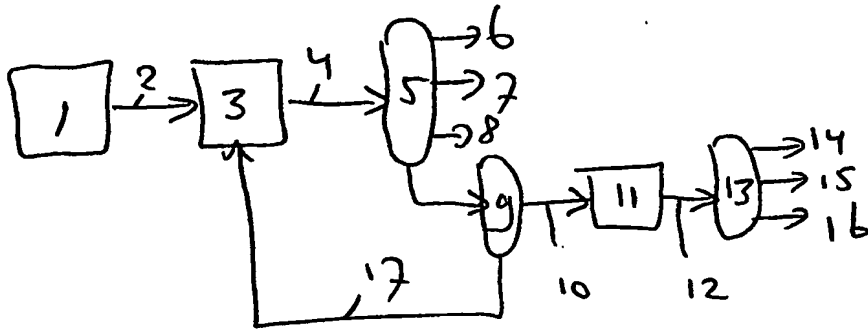


Fig. 1

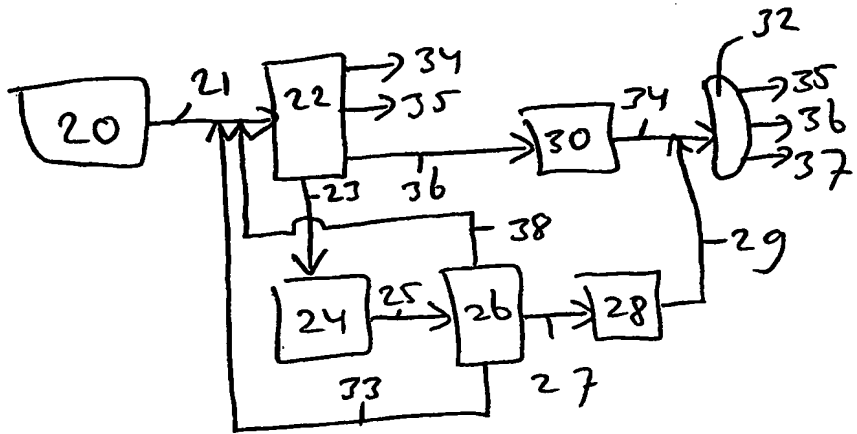


Fig. 2



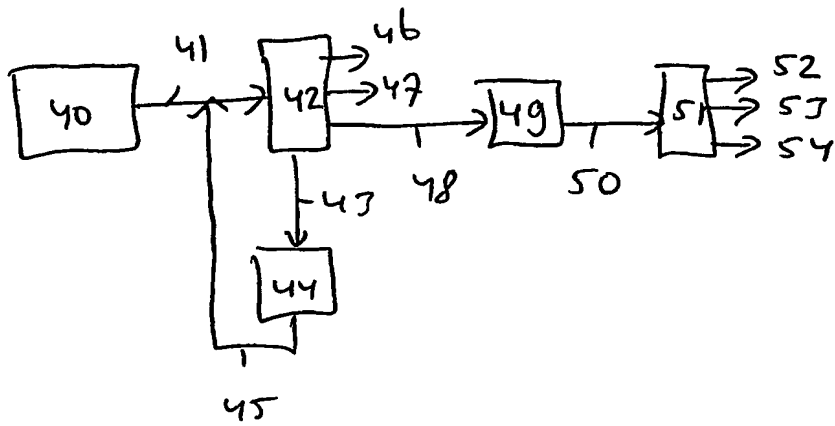


Fig. 3

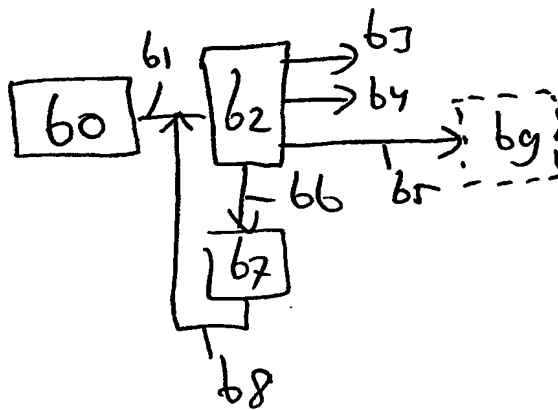


Fig. 4

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